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SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT I, Seiichi Kobayashi, a citizen of Japan residing at Kawasaki-shi, Kanagawa, Japan have invented certain new and useful improvements in

APPARATUS USING IN-BAND TYPE ACCESS SYSTEM

of which the following is a specification : -

TITLE OF THE INVENTION

APPARATUS USING IN-BAND TYPE ACCESS SYSTEM

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

The present invention relates to a transmission apparatus using an in-band type SNMP (Simple Network Management Protocol) system.

10 2. Description of the Related Art

In a general transmission system, a group of apparatuses linked via transmission spans is located in a network forming the transmission system in a distributed formation. In such a real network configured by points (a group of apparatuses) and
15 lines (a group of transmission lines), it is required to provide a management means or method for integrally managing the group of apparatuses and the group of transmission lines in such a manner that the network formed thereof is handled as only one
20 object for management. Such a management means makes it possible to link the apparatuses arranged in the distributed formation and thus bring up the network to only one object.

In an STM (SONET/SDH) transmission system,
25 the management means or method is realized by using an overhead provided separately from a user data field (payload) in a transmission frame. In the overhead, two independent data communication channels are defined. More particularly, the above
30 two independent data communication channels are respectively a section DCC (192 kbps) and a line DCC (576 kbps) where DCC is an abbreviation of Data Communication Channel. A data packet having a control information field is transmitted via the
35 data communication channels. In the control information field, headers in the respective hierarchical levels based on the information switch

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above ATM system as a virtual facility for conveying packets.

Originally, a site manager is defined in the management system of the LAN facility. An SNMP (Simple Network Management Protocol) application is utilized in the site manager. Management information collection and delivery by SNMP packets that are created and terminated by the SNMP application is replaced by an ILMI (Integrated/Interim Local Management Interface) which is defined on the virtual facility via which the LAN-system CLAD units are linked.

The transparency of management information collection and delivery based on the SNMP process by means of the ILMI can provide a guarantee within a request management area of the site manager placed on the real LAN facility which is not the virtual facility. However, the above transparency can manage only resources placed on the LAN facility, such as LAN-system terminals and routers (a group of LAN nodes) That is, the transparency excludes the CLAD units as objects for management.

In order to correlate the site manager with the resource information of the CLAD units themselves that connote the ATM transmission, it is required to provide SNMP-based information understandable by the site manager from the apparatus equipped with the CLAD unit, irrespective of whether the ATM transmission is connoted.

Conventionally, each of the apparatuses equipped with the CLAD units respectively provides, via a system separate from the system involved in transmission of the SNMP information concerning the ATM transmission, the site manager with the SNMP information concerning data transmission. The above separate system is a dedicated or leased communication line. Thus, the CLAD units are added

to the site manager as additional objects for management.

The use of the dedicated communication line for management of the CLAD units does not
5 flexibly cope with a change of connections between the CLAD units.

SUMMARY OF THE INVENTION

It is a general object of the present
10 invention to provide an apparatus in which the above drawback is eliminated.

A more specific object of the present invention is to provide a transmission apparatus using an in-band type access system having an
15 improved flexibility with regard to management of CLAD units without a limitation due to the physical scale of the involved network.

The above objects of the present invention are achieved by a transmission apparatus comprising
20 means for setting a resource management information path based on a given network management protocol onto PVC logically set traffic defined in ATM switching so that a customer network management agent process and a user network management system
25 can communicate with each other. It is to be noted that conventionally, resource management information is transmitted over the dedicated communication line. According to the present invention, the resource management information path is defined in a
30 transmission channel logically set on a payload carrier, and is transmitted along with user data (cells) in the ATM system. Thus, it is possible to avoid the problems resulting from the use of the dedicated communication line and to improve the
35 flexibility of applications to a large-scale WAN without physical limitations.

The transmission apparatus may further

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thereof shown in Fig. 7 and a peripheral part thereof; and

Fig. 9 is a block diagram of a detailed structure of the APC part of the transmission apparatus shown in Fig. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A description will now be given of a management method related to the present invention in order to facilitate better understanding of the present invention.

Fig. 1 shows a management method related to the present invention. A system shown in Fig. 1 includes user's LANs, namely, Ethernet LANs 101 and 102, and a token ring LAN 103. The Ethernet LAN 101 is equipped with a site manager (network management system) 104 and a router 107. The Ethernet LAN 102 is equipped with a site manager 105 and a router 108. The token ring LAN 103 is equipped with a site manager 106 and a router 109. The routers 107 - 109 are connected by dedicated communication lines. In the network shown in Fig. 1, the site manager 105 functions as a master, and the site managers 104 and 106 respectively function as slaves. The site manager 105 collects management information concerning the site managers 104 and 106 therefrom, and integrally manages the users' networks.

The Ethernet LANs 101 and 102 are media (LAN nodes, also called islands) that are physically and logically different from the token ring LAN 103. These media are linked by the dedicated communication lines. When the network shown in Fig. 1 is expanded to further include a new user's network, it is required to include a site manager in the new network and link it to the other existing site managers by means of dedicated communication lines.

More specifically, as the number of ATM transmission spans linking a large number of CLAD units, the number of end points for making interfaces with the site managers physically increases. In addition, complexity of the network configuration (topology) of the ATM transmission gives impetus to increase in the number of CLAD units. Thus, the above-mentioned management method cannot flexibly cope with alteration of connections between the CLAD units. Further, the management method is capable of achieving only a limited application, in terms of the physical scale, to a large-scale WAN (Wide Area Network) expected to be achieved by the ATM transmission. In practice, the large-scale WAN which employs a virtual LAN (VLAN) or an emulated LAN (ELAN) can be achieved within only a very limited area in which customer premises equipment (CPE) can be configured (for example, within a single user area, a campus or an office block).

Also, in a case where a large number of users' networks is integrally managed, it is very difficult to determine who performs the integral management and who bears the cost thereof including the cost of installation of the dedicated communication lines.

The present invention is made taking into account the above-mentioned issues. More particularly, the present invention is directed to flexibly coping with a change of connections between the CLAD units and making it possible to achieve a large-scale WAN by using ATM transmission without any limitation in terms of the physical scale.

A description will now be given of an embodiment of the present invention. The embodiment of the present invention described below is an application to a transmission apparatus (network

equipment) that can be called an "ATM channel switch integrated type composite system with an option of STM channel crossconnect and CLAD accommodation". Hereinafter, such a system is simply referred to as a transmission apparatus.

A description will first be given of the concept of the whole network configuration by referring to Fig. 2. Fig. 2 is a diagram for illustrating an access to a customer network management agent process from a network management system of each user, and a protocol stack utilized in the above process. The customer network management agent process performs an integrated management of the user's networks on behalf of the respective user's network management systems. The integrated management can be given in charge to a third provider (for example, a management company of an ATM public telephone network). In this case, the entrusted management company can place the transmission apparatus within its own network. Alternatively, a specific one of the management companies which manage the respective user's networks may integrally manage the user's networks.

Referring to Fig. 2, the whole network includes a customer premises network (CPN) 1, a service provider network (SPN) 2, and a network management system (NMS) 3, which system is placed outside of the networks 1 and 2. The management system 3 manages the whole network (except for management of the inside of the user's networks). The networks 1 and 2, and the network management system 3 are equipped with respective network equipment (NE), and are mutually connected via ATM transmission paths.

The customer premises network 1 is connected to a customer network management system (site manager) 11 via a user LAN facility 15 by

connection with the SNMP access (1), there is depicted a protocol stack utilized between the customer network management agent process 31 and the customer network management system 11 of the network 1.

A reference number (2) shown in Fig. 2 denotes that an SNMP access is made by using the transmission medium 4 (which is an ATM/user network interface or a LAN). In connection with the SNMP access (2), there is illustrated a protocol stack utilized by the SNMP access made on the transmission medium 4. In this case, a customer SNMP management path is not terminated by an SNMP (Simple Network Management Protocol) agent process (the detail of which will be described later) placed in the network element NE, but is bypassed.

As will be described in detail later, management information concerning the networks associated with and collected by the user-side site managers 11 and 21, that is, an SNMP management packet (message) is sent to the customer network management agent process 31 of the network management system 3 by utilizing an idle area available in the band of the ATM transmission path established between the transmission apparatuses rather than a transmission path on the switch side. The customer network management agent process 31 integrally manages the network management information concerning the respective user's networks.

Fig. 3 is a diagram showing routing of the SNMP management packet. In Fig. 3, symbols NE1, NE2, NE3 and NE4 are respectively network elements, and are respectively equipped with routers and SNMP agent processes, which will be described later. The network element NE1 is a transmission apparatus having a gateway function, and the network elements

NE2 - NE4 are respectively remote transmission apparatuses. The network element NE1 is placed in, for example, a switch office, and is connected with a network management system (or OSS: Operation Support System) which manages the whole network. Information is transmitted and received on an SNMP protocol data unit (PDU) basis. The above-mentioned network management system is additionally provided with the aforementioned customer network management agent process. The network elements NE1 - NE4 are connected together via ATM transmission paths. Provisioning is carried out between the routers of the network elements NE1 - NE4. More particularly, provisioning is carried out by using a permanent virtual channel (PVC) used as an information exchange path via which the SNMP management packet is routed to the destination SNMP agent process. Permanent virtual channels as described above are respectively defined between the routers.

As to the network element NE3, a customer in-band type SNMP access, which will be described later, is illustrated as an example. The SNMP management message or package has the following two access formations. The first access formation allows an access via the ATM/user network interface/customer premises equipment (CPE) accommodating the CLAD unit. That is, the access is made via an ATM/UNI information 62 which will be described later. The second access formation allows an access in the case of the CLAD unit direct accommodation (that is, the access is made via a LAN interface 61 which will be described later). The SNMP management message of the user network is sent to the network therefrom by using one of the two access formations, and is delivered to the customer network management agent process 31 via the PCV.

Fig. 4 schematically shows an example of a

subsystem and the CMISE subsystem.

In contrast, in the resource management of the CLAD unit itself accommodated in the transmission apparatus, particular cell transmission channels that are logically set on the payload carrier are used as user resources (a resource such as a LAN formation terminal and a router) and paths for collecting and delivering information concerning CLAD accommodating nodes, the paths being commonly owned in the network formed by the above nodes. The above resource management is implemented by a management process subset which is called an SNMP management subsystem and is capable of collecting node information.

The real substance of above three management subsystems is placed in a processor provided in the apparatus controller 64 which controls the apparatus information in the transmission apparatus, and commonly own a common management information base (CMIB: Common Management Information Base), which is controlled under the subsystems.

As an application of the present invention, a description will be given of the structure of resource management paths used for a CLAD unit resource defined as the in-band type SNMP access and a user resource (such as a LAN formation terminal or a router). The term "in-band type" of the in-band type SNMP access is used as a meaning that the resource information provision paths are assigned to particular cell transmission channels logically set on the payload carrier and the ATM transmission is performed together with user data (cells).

The transmission apparatus provides two SNMP interfaces. One of the two SNMP interfaces is an out-band (an external channel carrier) interface via an SNMP management port. The above out-band

interface is, for example, the Ethernet shown in Fig. 2. The other SNMP interface is an in-band interface which uses the service function part of the present transmission apparatus, such as an ATM/user network interface or an interface with a LAN. The ATM/UNI transmission medium 4 shown in Fig. 2 is an in-band interface. The term "in-band" is used as a meaning of a carrier subset provided by the particular cell transmission channel logically set on the payload carrier, as has been described previously.

The resource management of the CLAD units are configured so as to cope with the following two cases.

(1) Case 1 (a case via ATM/UNI interface 62):

The present transmission apparatus does not directly accommodate the CLAD unit. However, there is a case where a cell relay service provided by the present transmission apparatus brings the CLAD unit function by means of the CLAD unit provided in the customer premises equipment (CPE) located in a position opposite to the present transmission apparatus. In such a case, the SNMP management subsystem of the present transmission apparatus puts resource management information concerning the CLAD unit up on the customer network management agent process (CNM Agent) located outside. Thus, an exchange of the resource management information concerning the CLAD unit between the customer network management agent process and the site manager located on the side of the ATM cell relay service network is bypassed.

(2) Case 2 (a case via the LAN interface 61):

When the present transmission apparatus accommodates the CLAD unit, the SNMP management subsystem of the present transmission apparatus

provides resource management information concerning the CLAD unit.

In order to cope with the above-mentioned two cases, it is required that the out-band access and the in-band access cooperate with each other. Such a cooperation will be described with reference to Fig. 2.

The present transmission apparatus is equipped with an OS/NE (Operation System/Network Element) for the out-band access (see the OS/NE interface 24 shown in Fig. 2). Generally, the OS/NE interface is a LAN (Ethernet) or X.25. However, in the present embodiment of the invention, only a LAN port is presented as an interface with the out-band access because the LAN underlies the physical layer of the SNMP-system application (see Ethernet 1 shown in Fig. 2). The customer network management agent process 31 connected to the LAN port is the object of the out-band access. However, the customer network management agent process 31 is generally placed in an agent formation as a part of the network management system 3 of the user.

With regard to the in-band access, the site manager provided under the following condition is the object of the in-band access. That is, the site manager is connected to the LAN network extending to the user side via the CLAD unit in the customer premises equipment located in a position opposite to the present transmission apparatus by the cell relay service using the ATM transmission (see the LAN interface 12 shown in Fig. 2) or the CLAD unit which is directly accommodated in the present transmission apparatus (see the ATM/UNI interfaces 13 and 23 shown in Fig. 2).

In this regard, the in-band type SNMP access is implemented by forming the information path of the customer network management agent

Datagram Protocol/Internet Protocol).

5 The SNMP agent process function as shown
in Fig. 3 handles the SNMP management information
and prepares SNMP information exchange requests and
a response process for these requests. More
particularly, the SNMP agent process that has the
common management information base (CMIB) under the
control accesses the common management information
base by using an appropriate application interface
10 when the SNMP management message comes to the
present transmission apparatus via the SNMP
management port irrespective of whether the message
is based on the in-band access or the out-band
access. Then, the SNMP agent process gets
15 information from an abstraction function unit placed
in the common management information base and sets
(requests) an operation as a logical window of a
detection system (such as condition, PM, or alarm)
or an operation system (control or provisioning)
20 which cooperates with the physical substance of the
present transmission apparatus.

In addition, the SNMP agent process also
supports an autonomous report process. More
particularly, the SNMP agent process transfers
25 information concerning a predetermined failure in
hardware or software to all SNMP management
providers in the network by a method called an SNMP
trap, so that internal information in the respective
SNMP management providers can be updated.

30 The in-band access system operation
requires the following functions which serve as
hands and feet for exchanging information by the
above-mentioned SNMP management subsystems.

IP routing function

35 An IP routing function is implemented on
the SNMP management subsystems, and routes, from the
OS/NE interface, all SNMP management packets sent by

present transmission apparatus. Fig. 7 is a block diagram of a control system of the present transmission apparatus, and Fig. 8 is a block diagram of an APC (ATM Processing Control) part of the control system thereof and a peripheral part thereof. Fig. 9 is a block diagram of a detailed structure of the APC part of the present transmission apparatus.

First, a description will be given of the whole operation and function of the present transmission apparatus.

Referring to Fig. 5, the SNMP protocol data unit (PDU) of the site manager interfaced by the ATM/UNI (via CPE) or LAN (direct accommodation) is coupled to a service complex of the present transmission apparatus shown in Fig. 5 in such a manner that an ATM/UNI channel card is coupled in the ATM cell formation and a LAN card is coupled in the packet formation. These cards are those among a group of cards called "trib" (see Fig. 6). The SNMP protocol data unit thus coupled to the service complex interfaced by the ATM/UNI channel card is sent to a switching complex shown in Fig. 5 as it stands (without missing the ATM cell formation). The SNMP protocol data interfaced by the LAN, which is arranged in the package formation, is mapped, by segmentation, on the ATM cell(s) by the CLAD unit accommodated in the transmission apparatus. The ATM cell thus produced is sent to the switching complex.

The SNMP protocol data unit arranged in the ATM cell formation is applied to the switching complex and is taken in an STS-SF (Synchronous Transport Signal Switch Fabric) card shown in Fig. 6. Then, the SNMP protocol data unit is transferred to an ATM-SF card having ATM visibility shown in Fig. 6. The ATM-SF card compares the VPI/VCI values corresponding to the IP address with which the SNMP

order process, and is utilized as a database configuration information element for performing the LAN-system resource management and network management.

- 5 The database thus built up can be referred to by the external customer network management agent process by coupling the LCN port on the DCC by means of the NECPU-DCC-LCN system path.

10 Referring to Fig. 5, the whole function configuration of the present transmission apparatus is made up of the following five complexes. Each of the five complexes has the following functions.

Transport complex

- 15 -LINE terminating function
 -SONET (OC-n)/SDH transport function

Service complex

- TRIB terminating function
 -STM/ATM/LAN/FR accommodating function
where FR is an abbreviation of the frame relay

20 Switching complex

- LINE/TRIB traffic (data unit and frame timing) connecting function on the STS/VT/ATM cell bases
 -STS/VT-TSI function by crossconnect
25 -VC/VP-ATM exchanging function

Synchronization complex

- System timing synchronizing function by determination and distribution of in-apparatus timing

30 Management complex

- Severance by in-apparatus information collection and exchange and as carrier quality checking and performance evaluating function
 -Apparatus operation executing (including
35 download and backup) function
 -Network management (TL1, FTAM, CMLSE, SNMP, FTP) interface function.

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Referring to Fig. 6, packages/units forming the hardware structure of the present apparatus are configured by groups of regular or optional packages/units as described below. The

5 terms "regular" and "optional" are a category on an application function basis. Another category based on a discrimination between electrical and optical carriers, a working/protection discrimination, a large/small channel capacity and a

10 performance/capability based grade is a menu of packets/units.

(1) Regular package/unit

Transport complex

-LINE ... OC-12 (STS/STSc/CRS)/OC-3

15 (STS/STSc/CRS) where CRS denotes cell relay service.

Service complex

-TRIB ... DS1(VT1CRS)/DS3(STS/CRS)/DS1FR/LAN (electrical signal system Ethernet) where FR denotes frame relay.

20 Switching complex

-STS-SF,VT-SF,ATM-SF/APC where APC denotes ATM processing control.

Synchronization complex

-SYNC

25 Management complex

NECPU/DCC/APS-HUB where APS-HUB denotes automatic protection switching, hubing where APS is an abbreviation of Automatic Protection Switching.

(2) Optional package/unit

30 Transport complex

-LINE ... OC-48 (STS/STSc/CRS)

Service complex

-TRIB ... DS1CE/DSIMA/DS3TR/DS3FR/DS3CE/LAN (optical signal system Ethernet)/LAN (token

35 ring)/SPC where CE denotes circuit emulation, IMA denotes inverse multiplex adapter, TR denotes transmux, and SPC denotes service processing control.

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the crossconnections based on the procedure between the exchange intelligence parts is recorded as an exchange execution unit. There is also provided with means for controlling the use of channels in a quantitative fashion on the basis of whether an exchange connection fails or not.

The autonomous crossconnections are categorized into any of the following three types, PVC, software PVC and SVC, which depend on the subject which issues a request. The PVC and software PVC execute the static allocation. There is a PVC which indicates a connection route in a fully manual fashion, and a software PVC in which predetermined route information is input and set and connection route information is determined with a help of a PNNI (Private Network to Network Interface) software. The SVC executes a dynamic allocation. Also, as an independent control algorithm, the ATM-SF and APC perform an APS (Automatic Protection Switching) control for execution of ATM path protection (VP servivility) and manages the execution.

(6) SNYC

This handles a system timing synchronization due to determination and distribution of the in-apparatus timing.

(7) NECPU

This maintains the in-apparatus management information base. This serves as a brain which supplies, by messages, associated hardware parts with concrete instructions based on logical actions extended in the virtual field by an external operation so that the logical actions are changed to physical and tangible actions. More particularly, the NECPU executes surveillance, quality check and performance evaluation due to in-apparatus information collection and exchange and executes

operations on the transmission apparatus (including download and backup).

(8) DCC

5 This has a physical path for information exchange with the external operation and a logical channel equipped with a connection procedure on a layer structure (protocol) basis. The DCC cooperates with the NECPU to form the network management (TL1, FTAM, CMISE, SNMP, FTP) interfaces.

10 (9) APS/HUB

15 This functions as an actuator, which directly contacts packages/units forming hardware parts which are in charge of transport, service, switching, synchronization and so on, and interprets operation messages issued by the NECPU or the like in order to convert the operation messages into the physical and tangible actions. The APS/HUB also functions as a sensor which collects and interprets physical and tangible states and phenomena of the packages/units, and sends resultant operation messages to the NECPU. Further, as an independent control algorithm, the APS/HUB is in charge of APS control and management of execution. Examples of the APS control are path protection (UPSR, STS-BLSR, 20 VT-BLSR), line protection (optical units), apparatus protection (electrical units, and units in switching and synchronization complexes).

25 (10) OW, MDM

30 This has an order wire function and a modem unction which extends a local craft to a VF band for remote crafting.

The present invention is not limited to the specifically disclosed embodiments, and variations and modifications may be made without 35 departing from the scope of the present invention.